Chiral differential operators on classical invariant rings via BRST reduction

Tomoyuki Arakawa
RIMS, Kyoto University

We present a uniform geometric framework that connects the representation theory of vertex algebras with symplectic geometry and invariant theory. More precisely, we construct chiral analogues of differential operators acting on classical invariant rings as global sections of sheaves of chiral differential operators associated with vector bundles on smooth open subvarieties of affine GIT quotients, using BRST reduction.

Within this framework, we develop a localization theory for modules over these global sections, following Borisov's approach, and establish several fundamental properties of the resulting vertex algebras. As an application, we construct new infinite families of simple conformal quasi-lisse vertex algebras, which we expect to arise from 3D $\mathcal{N} = 4$ gauge theories.

This is joint work with Xuanzhong Dai and Bailin Song.

Invariant holonomic systems in the bi-Whittaker setting

Wenwei Li
BICMR, Peking University)

Motivated by the Bessel distributions on quasi-split real groups, we study certain $\mathcal{D}$-modules of Hotta-Kashiwara type with bi-equivariance under a maximal unipotent subgroup by a non-degenerate character, up to completion with respect to a certain unbound filtration. This involves bi-Whittaker reduction of differential operators on G, geometry of universal centralizer, an isomorphism to nil-DAHA (due to Ginzburg) and duality theory for non-commutative rings. Such results are parallel to recent works of Bellamy-Nevins-Stafford for infinitesimal symmetric spaces. This is a work in progress.

Categorification of k-Schur functions and refined Macdonald positivity

Syu Kato
Kyoto University

For type A, a modified version of Macdonald polynomials exhibits positivity, conjectured by Macdonald in the late 80s and proved by Haiman in 2002. In the meantime, LaPointe-Lascoux-Morse (1998, published in 2003) proposed a conjectural refinement of the Macdonald positivity by introducing the notion of k-Schur functions.

In her 2009 thesis written under the supervision of Haiman, Li-Chung Chen proposed a conjectural module-theoretic characterization of k-Schur functions, that explains the reason as to why such a refinement of Macdonald positivity should hold.

In this talk, I will exhibit a family of algebraic varieties whose Borel-Weil theory represent Catalan symmetric functions, encompassing Hall?Littlewood and k-Schur functions as a proper subclass.

Then, we outline our program how to deduce the above conjecture(s) of Chen-Haiman from the analysis of these algebraic varieties.

An algorithm for Aubert-Zelevinsky duality

Thomas Lanard
CNRS-UVSQ

The Aubert-Zelevinsky duality is an involution on the irreducible representations of a p-adic group, playing a central role in representation theory. For GL_n, irreducible representations can be classified by combinatorial objects called multisegments. In this case, an explicit formula to compute the Aubert-Zelevinsky dual was given by Moeglin and Waldspurger. For classical groups such as Sp_{2n} or SO_{2n+1}, irreducible representations can be described in terms of Langlands parameters. In this talk, I will present a combinatorial algorithm, inspired by the Moeglin-Waldspurger approach, to compute the Aubert-Zelevinsky dual in terms of Langlands data. Interestingly, the algorithm was discovered with the help of machine learning tools, which guided us toward patterns leading to its formulation. This is joint work with Alberto Mínguez.

I will also present a web application, langlandsprograms.com, developed in collaboration with Petar Bakić and Elad Zelingher, where this algorithm has been implemented and can be explored interactively.

The socle filtration and singularity of intertwining operators for degenerate principal series

Ning Li
Nankai University

The theory of intertwining operators was first systematically studied for real reductive groups by Knapp and Stein. It lies at the crossroads of harmonic analysis and representation theory. It is known that there is a deep relation between the analytic theory of intertwining operators and the algebraic theory of parabolically induced representations. In this talk, we will introduce two different notions of level ranks attached to an unramified degenerate principal series of a classical group. Moreover, we will establish a local "BSD-type" formula for these two notions. This is based on a joint work with Caihua Luo, Xu Song and Chuijia Wang.

Critical stable envelopes and quantum cohomology

Andrei Okounkov
Columbia University

TBA

(q,t)-Decomposition matrices for finite groups of Lie type

Raphaël Rouquier
UCLA

I will discuss a joint work with Olivier Dudas. We propose a new approach to decomposition matrices of finite groups of Lie type in large non-describing characteristic. We conjecture that it is a specialization of a combinatorially defined matrix with coefficients Laurent polynomials in two variables. For general linear and unitary groups, this is related to new bases in toroidal Fock spaces.

Duality functors for Coulomb branches

Sabin Cautis
The University of British Columbia

We define an exact functor from the category of finite dimensional modules over a quiver Hecke algebra of affine type ADE to the Coulomb category of finite type ADE constructed in recent work with H. Williams. This functor factors through a certain localization of the module category, studied by Kashiwara-Kim-Oh-Park, to give a faithful functor. One can use this, for example, to identify the Coulomb branch with an open Richardson variety and to prove that the Coulomb category is a monoidal categorification of a quantum cluster algebra. This is a joint project with E. Vasserot.

On the Betti numbers of compactified Jacobians

Oscar Kivinen
Aalto University

We prove a conjecture of Cherednik describing the Betti numbers of compactified Jacobians of unibranch planar curves via superpolynomials of algebraic knots. The methods of the proof use the theory of orbital integrals and affine Springer theory.

Extension between simple and costandard modules in modular BGG category $\mathcal{O}$

Quan Situ
Université Clermont Auvergne

In representation theory, it is fundamental to understand the simple objects. In a highest weight category, some information about simple objects can be read off from their extension groups to the costandard objects.

In this talk, we will consider $(\mathfrak{g}, B)$-modules, namely the strongly B-equivariant $\mathfrak{g}$ modules, where $\mathfrak{g}$ is the Lie algebra of a reductive group G over positive characteristic and B is a Borel subgroup of G. It is an analogue of BGG category $\mathcal{O}$ over positive characteristic. We express the dimension of

extension between simple modules and costandard modules by the coefficients of periodic Kazhdan-Lusztig polynomials, when the characteristic is large enough. If time permitted, I will also discuss a motivation from the geometry of semi-infinite orbits on the affine flag variety. This is a joint work with Simon Riche.

Counting indecomposable G-bundles

Zhiwei Yun
MIT

The notion of absolutely indecomposable vector bundles over a curve naturally appear in the consideration of automorphic forms. Since they do not form an algebraic stack, it is a surprising fact that its point-counting over a finite field is still "motivic", i.e., equal to the number of points in some other stack, namely the moduli of stable Higgs bundles. This was proved by Schiffmann more than a decade ago when the degree of the vector bundle is coprime to the rank, and extended by Dobrovolsk, Ginzburg and Travkin to all degrees.

One can formulate the same counting problem for absolutely indecomposable G bundles, where G is any connected reductive group. The previous arguments for vector bundles don't obviously generalize to G-bundles.

In joint work with Konstantin Jakob, we solve the counting problem for absolutely indecomposable G-bundles for all reductive G uniformly. We show that the answer, as in the $GL(n)$ case, can be expressed using the number of stable (parabolic) G-Higgs bundles on the same curve.

Geometric Satake for Kac-Moody groups

Alexis Bouthier
IMJ-PRG

We explain how to make sense of the category of $G(\mathcal{O})$-equivariant perverse sheaves on the affine grassmannian of a Kac-Moody group G and establish an equivalence of abelian semisimple categories with the category of representations $\mathrm{Rep}(G^\vee)$ of the Langlands dual. It is a joint work with E. Vasserot.

Seiberg-Witten geometry and the double affine Grassmannian

Alexander Braverman
Perimeter Institute

We present a program for realizing the total space of the Seiberg-Witten integrable system for $4d\mathcal{N} = 2$ gauge theory for a gauge group G (a.k.a. the Coulomb branch of this theory on a cylinder in the "Hitchin type" complex structure) as a version of the Braverman-Finkelberg-Nakajima construction attached to the affine Kac-Moody group of G. The construction is conjectural at the

moment but we present some rigorous results in the case when G is abelian (and relate the answer to the theory of the so called "Dolbeault hyper-toric varieties").

Shifted quantum groups and cluster algebras

David Hernandez
IMJ-PRG, Université Paris Cité

Shifted quantum affine algebras emerged from the study of quantized Coulomb branches. We show that the Grothendieck ring of the category $\mathcal{O}$ for the shifted quantum affine algebras has the structure of a cluster algebra. The cluster variables of a class of distinguished initial seeds are certain formal power series defined from a Weyl group action introduced in a joint work with Frenkel. We extend the construction to non simply-laced types, for which the Langlands dual algebra play an important role. This a joint work and an ongoing project with C. Geiss and B. Leclerc.

Representations of shifted affine quantum groups and Coulomb branches

Michela Varagnolo
CY Cergy Paris Université

I will present an equivalence between the category $\mathcal{O}$ for shifted quantum loop groups (associated with arbitrary Cartan matrices, including non-symmetric ones) and a module category over a new type of quiver Hecke algebra.

This equivalence is based on the computation of the K-theoretic analogue of Coulomb branches with symmetrizers introduced by Nakajima and Weekes.

At the decategorified level, this yields a connection between the Grothendieck group of $\mathcal{O}$ and a finite-dimensional module over a simple Lie algebra of unfolded symmetric type. In some cases, this module can be computed explicitly; more generally, one can describe its crystal structure via a combinatorial rule. Joint with Eric Vasserot.

Categorification of skein algebras

Dylan Allegretti
YMSC, Tsinghua University

The skein algebra of a surface is a noncommutative algebra that quantizes the $\mathrm{SL}(2,\mathbb{C})$-character variety of the surface. It has been intensively studied in quantum topology for more than thirty years. In an influential paper from 2014, D. Thurston suggested that the skein algebra should have a natural categorification where the product in the algebra arises from a monoidal structure on a category. In this talk, I will describe such a categorification of the skein algebra of a genus zero surface with boundary. I will explain how this algebra arises as the Grothendieck ring of the bounded derived category of equivariant coherent sheaves on the Braverman-Finkelberg-Nakajima

variety of triples with monoidal structure defined by the convolution product. This talk is based on work with Hyun Kyu Kim and Peng Shan.

A correspondence of Arthur packets between real unitary groups and p-adic special odd orthogonal groups

Bin Xu
YMSC, Tsinghua University

We establish an explicit correspondence of certain Arthur packets between real unitary groups and p-adic special odd orthogonal groups. As an application, we can compute the Arthur packets of real unitary groups by translating the results from the p -adic side. The main feature of our proof is to relate the Zuckerman's translation functor on the real side with the Jacquet functor on the p-adic side. To achieve this, we construct a correspondence of stacks of Langlands parameters with fixed infinitesimal characters between the relevant real and p -adic groups. It also allows us to relate the Kazhdan-Lusztig polynomials and the microlocal geometry between real and p-adic cases. This is joint work with Taiwang Deng, Chang Huang and Qixian Zhao.

ℓ-Modular Blocks of $\mathrm{SL}_n(F)$

Peiyi Cui
AMSS, CAS

Reduction to depth zero is a promising approach for understanding ℓ modular blocks of p -adic groups when ℓ differs from p . In this talk, I will introduce some examples of depth zero blocks and all the ℓ-modular blocks of SL_n from this perspective. We will explore the technical challenges in associating an ℓ-modular block with a depth-zero block and consider a natural candidate for this potential connection. Toward the end, I will also discuss related topics on both the automorphic and Galois sides.

COHA's and χ-independence for K3 surfaces

Eric Vasserot
IMJ-PRG, Université Paris Cité

BPS invariants naturally appear in the enumerative geometry of sheaves with one-dimensional support on a Calabi-Yau threefold. Toda conjectured that these invariants are independent of the Euler characteristic χ of the sheaves. I will explain a proof of this conjecture in a joint work in progress with Davison-Hennecart-KinjoSchiffmann for the case of K3 surfaces. This proof is based on Cohomological Hall algebras. To do this I will first recall the general theory of COHA's and BPS sheaves.

The BPS decomposition theorem

Lucien Hennecart
CNRS - Université de Picardie Jules Verne

In this talk, I will explain joint work with Tasuki Kinjo (Kyoto), whose goal is to establish a quantitative version of the decomposition theorem (in the sense of Beilinson-Bernstein-Deligne-Gabber) for the morphism from a symmetric algebraic stack to its good moduli space.

This result provides a formula allowing one to reconstruct the cohomology of smooth stacks from the intersection cohomology of the stacks of graded points. It has applications to the study of the Borel-Moore homology of 0-shifted symplectic stacks and to the critical cohomology of (-1)-shifted symplectic stacks. I will discuss consequences for the purity of Hodge structures and a Kirwan surjectivity theorem for the restriction morphism to the semistable locus.